

# HEC-RAS 3.1

## November 2002

### Release Notes

New versions of HEC-RAS (3.1) and HEC-GeoRAS (3.1) have been released with significant new features over the previous versions (3.0). Version 3.1 of HEC-RAS includes several new features for unsteady flow routing, as well as some for steady flow water surface profile computations. All three of the HEC-RAS documents have also been updated, and are available to download from the HEC web page. **All of the documents are in Adobe PDF format and require the Adobe Acrobat 5.0 Reader or newer.** If you do not have this version of the PDF reader you can download it for free from the Adobe web page:

<http://www.adobe.com/products/acrobat/readstep.html>

The following is a list of the new features that have been added to the software, as well as bugs that have been fixed.

#### A. New Unsteady Flow Routing Features

1. **Dam Break Analysis** – HEC-RAS can now perform a Dam Breaching analysis. The user enters information about the size and dimensions of the breach, as well as how long it will take to form. The software will then perform unsteady flow routing of the flood wave through the breach and on down stream. This feature is documented in Chapter 16 of the User's Manual.
2. **Levee Breaching** – This feature is very similar to the Dam Break capability described above. The user models a levee as a lateral structure in HEC-RAS. They can then define the location, size, shape, and time for the breach. The breached flow can go into a storage area, or it can be connected to another river reach. Levee breaching is documented in Chapter 16 of the User's Manual.
3. **Mixed Flow Regime For Unsteady Flow** – HEC-RAS can now perform mixed flow regime (subcritical to supercritical, as

well as hydraulic jumps) calculations during an unsteady flow run. This feature is documented in Chapter 16 of the User's Manual.

4. **Pump Stations** – HEC-RAS now has the capability to model pump stations. The user can attach a pump station to a storage area or a river reach. Each pump station can have up to 10 non-identical pump groups, for which a different pump efficiency curve (head versus flow) can be entered. Each pump group can have up to ten identical pumps (same pump efficiency curve). However, every pump can have a different on and off trigger elevation. The HEC-RAS pump capability is documented in Chapter 16 of the User's Manual.
5. **Navigation Dams** – This feature will optimize gate settings for a navigation dam in order to maintain an upstream water surface within a specified range. This feature is documented in Chapter 16 of the User's Manual.
6. **Culvert Flap Gates** – This feature allows the user to put a flap gate on a culvert that is defined as part of a lateral structure. The flap gate can be set to allow water to only flow in one direction through the culvert. Flap gates are documented in Chapter 6 of the User's Manual, under the section describing lateral structures.
7. **Floodway Encroachments** – Floodway encroachments can now be analyzed during an unsteady flow simulation. Encroachments for unsteady flow are documented in Chapter 10 of the User's Manual.
8. **New Flow Data and Boundary Conditions Features** – Several new features have been added to the Unsteady Flow Data editor. The following is a list of those features:

**Internal River Station Initial Stages:** allows the user to set a water surface at any river station for the initial conditions.

**Minimum Flow and Flow Ratio Table:** This option allows the user to specify a minimum flow for any of the flow hydrograph

boundary conditions being used in the simulation. Additionally, there is an option to enter a ratio that will be multiplied by every ordinate in a flow hydrograph boundary condition.

**Observed (Measured) Data:** In the previous version of HEC-RAS the user could specify a DSS pathname that contained observed flow or stage time series data. When this is done, that observed data can then be plotted with computed values on the hydrograph plotter, profile plots, and cross section plots. Two new options have been added, **High Water Marks** and measure **Rating Curves** (mean curve and measured points can be entered). When high water marks are entered, they will show up on the profile plots as well as the cross section plots. When entering measured rating curves, the user-entered mean curve and measured points will show up on the rating curve plots, along with the computed values.

9. **Initial Conditions Flow Optimization** – This option allows the user to direct the program to try to optimize the flow at junctions and lateral structures for the calculation of the initial conditions. Initial conditions are computed with a standard step backwater, and it is up to the user to put in initial estimates of the flow. Sometimes these estimates do not always result in consistent water surfaces for initial conditions...which in turn, can cause the unsteady flow calculations to go unstable right at the beginning of the simulation. By optimizing flow splits and flow leaving the main river, these instabilities may be minimized. This option is available from the **Options** menu of the Unsteady Flow Analysis window.
10. **Log File Output** – The Log File Output for Unsteady flow calculations has been dramatically improved. The log file is used to assist users in debugging computational problems. User's now have much more control over what and how much information gets written to this file. Additionally, the format of the information has been made easier to read and understand.

## **B. New Geometric Data Features**

1. **Improved Background Map Viewing for River System Schematic** – We have changed the background mapping and imaging capability within the geometric editor to allow for a wider range of image types. We are now using a commercial package from ESRI, called Map Objects Light (ESRI, 2002). This package is a library of routines that can be used for map and image display. There is no licensing fee or requirement to have any other ESRI product in order for this to work. More information on Background images for the river system schematic can be found in Chapter 6 of the User's Manual.
2. **New Terminology for Inline and Lateral Structures, as well as Storage Area Connections** – Previously in version 3.0, we used the terms “Inline Weir/Spillway”, “Lateral Weir/Spillway”, and “Hydraulic Connections”. These terms have been changed to more generic names in order to account for the fact that we now allow for a wider range of hydraulic features to be combined at each of these structure types. The new names, and their use are described below:

**Inline Structure:** Can be used to model a hydraulic structure that crosses the main stream. This structure can have gated spillways, as well as a free flowing overflow weirs/spillways.

**Lateral Structure:** Can be used to model a hydraulic structure that is lateral (parallel) to the main river. This type of structure can remove flow from the river, or bring flow into the river. A lateral structure can be connected to a Storage Area or to another river reach. Lateral structures can contain gated spillways, culverts, free flowing overflow weirs/ spillways, and user-defined diversion rating curves. Additionally, an option exists to perform a simple linear routing between the river and to whatever the lateral structure is connected.

**Storage Area Connections:** Storage area connections allow the user to model the transition of flow from one storage area to another. This option allows the user to define a hydraulic

structure using a free flowing weir, weir and gated spillways, weir and culverts, or a simple linear routing option.

For more information on any of these three hydraulic structure types, refer to Chapter 6 of the User's Manual and Chapter 8 of the Hydraulic Reference Manual.

3. **Improved Interface to GIS (GeoRAS)** – The interface for reading and writing information from and to a GIS using GeoRAS has been improved. Users now have much more control over what is brought into HEC-RAS and how existing information gets updated with new information. The new interface is documented in Chapter 6 of the User's Manual.
4. **Flow and Seasonal Roughness Factors Stored in Geometry** – Previously, when a user defined a flow versus roughness or seasonal roughness change, the information was stored as part of the Plan file. This capability allowed a modeler to make changes to the roughness without re-running the geometric preprocessor (this is a common need in real-time forecasting). However, it is recognized that these changes may also be appropriate as permanent values that should always be applied to the geometry data. Therefore, we have added the same features directly into the geometric data editor. These two features can be found under the **Tools** menu bar of the Geometric Data Editor. They are generally used for unsteady flow modeling, but the flow versus roughness can also be used for steady flow modeling.
5. **Improved Display of Information on The River System Schematic** – We have added the ability to highlight in red the current active node (cross section, bridge, culvert, hydraulic structure, etc.). Additionally, a red circle is drawn around it in order to make it easy to find on the schematic. The active node is whichever node was the last one to be viewed in a data editor or output window.
6. **New Data Editing Tables For Geometric Editor** – The following data editor tables have been added to the geometric editor (under the Tables menu bar), to allow easier editing of

multiple locations and global information: Levee Elevations; Node Descriptions; Picture File Associations; Weir and Gate Coefficients; and HTAB Internal Boundaries (Geometric Pre-processor). For a detailed description of each of these tables, please read Chapter 6 of the User's Manual.

7. **New Data Manipulation Tools For Geometric Editor** – The following is a list of the new geometric editor tools that have been added: View reach connectivity; Datum adjustment; Fix overlapping ineffective areas; GIS coordinates manipulation; Reach order for computations; and Find loops in river system schematic. Documentation for these features can be found in Chapter 6 of the User's Manual.

### C. New Hydraulic Design Functions

In addition to the existing pier scour function, HEC-RAS can now perform uniform flow computations, stable channel design, and sediment transport capacity computations for existing geometry.

1. **Uniform Flow Computations** – For a selected cross section, any of the parameters of Manning's equation can be computed, when the other parameters are input by the user. For example, if the user wishes to know the discharge, the slope and water surface elevation must be entered along with the existing cross section, and the discharge will be solved. A number of different roughness analysis techniques can be used, including Manning, Strickler, Keulegan, Limerinos, Brownlie, and the SCS Grass Curves. Channel width can also be solved, but in this case, an idealized cross section with up to three trapezoidal templates must be used.
2. **Stable Channel Design** – This function can be used to determine the channel geometry and characteristics needed to achieve channel stability at a given cross section. The user has the choice of using Copeland's method, Regime method, or Tractive Force method. Similar to the Uniform Flow Computations, a number of parameters are entered by the user, and RAS outputs the parameters required for channel stability.

For this function, only idealized trapezoidal channels can be used.

3. **Sediment Transport Capacity**– The sediment transport capacity at any existing cross section can be determined using this feature. Six transport methods are available, which include Ackers-White, Engelund-Hansen, Laursen, Meyer-Peter Müller, Toffaleti, and Yang. Transport Capacity can be analyzed for the main channel or overbanks and by grain size for each water surface profile selected. Output is presented in sediment profile plots, sediment rating curve plots, and their respective tables. The plots have the option to display general results such as total sediment transport capacity for the entire cross section, or specific results such as sediment transport capacity for a given grain size in the main channel only.

#### **D. Help System and Manuals**

1. **New Help System** – The HEC-RAS help system has been updated to reflect the new documentation and features added to the software. User's can activate the help system from any of the HEC-RAS windows. Either select the help option from the menu bar or press the F1 key.
2. **New Manuals Online** - All three HEC-RAS manuals (User's, Hydraulic Reference, and Applications Guide), have been updated and put into PDF format. These manuals can now be viewed from within the HEC-RAS software by selecting one of the three manuals from the Help menu on the main HEC-RAS window. When a manual is selected, a table of contents for that manual will come up. Simply click on the information you want to read about, that chapter will be loaded and it will automatically go to the location selected within that chapter.  
**Note: Adobe Acrobat 5.0 Reader or newer is required to read the HEC-RAS manuals.** If you do not have this version you can download it for free from the Adobe web page:

<http://www.adobe.com/products/acrobat/readstep.html>

3. **Custom Help Files** - Users can add a file link to the main RAS help menu bar by adding a file to the \Program Files\HEC\RAS directory that starts with "RasHelp\_". For example, a help file in Spanish can be added with a file labeled: "RasHelp\_Spanish Glossary.hlp" (it is up to the user to create this help file). Other file types can also be added, for example: ".txt", ".doc", ".xls", etc. When files beginning with the "RasHelp\_" text and ending with a common file type extension are added to this directory, they will automatically show up under the Help menu for user viewing.

## **E. Graphical and Tabular Output**

1. **Cross-Section Plots** – New animate, record, and picture buttons have been added to the cross-section plot. The Animate button allows you to animate the change in water surfaces over time for an unsteady flow run; the Record button allows you to record an AVI movie file of the animation; and the Picture button allows you to view or attach a picture to specific cross sections.

Also, the "A" and "Z" keys can be used to show similar plots up and down the river system.

2. **Profile Plot** – New buttons have been added to this plot to make it more convenient to select river reaches and which profiles to plot. Additionally, buttons for animating the plot, recording an AVI movie of the animation, and reloading the data from a new run have been added.
3. **Rating Curve Plot** – The animate, record AVI, and picture buttons have been added to this plot as described above.
4. **Hydrograph Plots** – The following new features have been added to the hydrograph plotting capability:

**Hydrograph Statistics** – A window has been added to the upper right hand corner of the plot window to display statistics about the computed flow and stage hydrographs, as well as any

observed data at this location. The statistics include the peak stage and time, the peak flow and time, and the volume of the hydrograph. If observed data are attached at this location, additional statistics will appear, including: observed peak stage, time, and lag (difference in computed and observed stage times); observed peak flow, time, and lag; and observed volume, difference between computed and observed volume, and percent difference in volume.

**Calibration Aids** – Tabs have been added for a rating curve plot, computed minus observed stage versus flow, and computed minus observed stage versus season. The rating curve plot is different than the general one in that it plots stage versus flow sequenced in the time that they actually occurred. This plot can show any loops in the rating curve that may have been computed or observed. The computed minus observed stage versus flow tab shows how the errors in the computed stages varied with flow rate. The computed minus observed stage versus season tab shows the errors that may vary over time. All of these tabs are very useful when calibrating an unsteady flow model.

**Selecting Variables To Plot** – New check boxes have been added directly above the tabs to allow the user to quickly turn variables on or off. This includes stage, flow, observed stage, observed flow, and whether or not to use a reference elevation for scaling the plot (invert of the cross section is used as minimum elevation for stage scale).

5. **3-D Graphic** – Users can now display the river stations on this plot.
6. **Hydraulic Tables Plot (HTAB)** – A new button has been added to this plot in order to more conveniently turn the plot variables on and off.
7. **Detailed Output Tables** – Some new table types have been added to the detailed output table window, these include: multiple openings, storage areas, storage area connections, and pump stations. Additionally, a Plan selection button has been

added to the window in order to view detailed output from other plans without opening the entire plan data.

8. **Summary Output Tables** – A new summary table type has been added for pump stations. Additionally, we have added the ability for a user to create a table that contains only the specific river station locations (nodes) that they want. After creating the list of specified locations, the new summary table can be saved for later recall.
9. **DSS Viewer** – The HEC-DSS viewer has been updated to handle larger DSS files.
10. **General Graphics Features** – The following items have been added to all of the 2-D graphics:
  - With the mouse over the graphic, if you click the left mouse button, the program will find the nearest point and display its river and reach name, river station, and X and Y value.
  - All of the data values that make up the graphic can be copied to the clipboard. This can be accomplished from the File menu of each graphic.
  - The user can measure distances on the graphic by holding down the control key and then moving the mouse. When the control key is released, the measured distance is displayed.
11. **Cross-Section Editor** – The graphic of the cross section is more closely tied to the cross section data editor. Data in the plot changes when the Apply Data button is pressed on the editor. The plot also changes to a new cross section when a new cross section is selected from the editor.

## F. General

1. DSS Viewer - has a new utility to copy DSS paths.
2. If observed DSS pathnames are added to the unsteady data editor, the cross section locations are automatically added to the flow and stage output locations (HY records).
3. The stage-flow plotter allows users to set the number of decimal places in the table.
4. Edits to line and symbol style now persist until a plot is closed.
5. The flow and stage plotter now shows a vertical red line at the time of the current profile viewed in animation.
6. Profile Plot now shows River names with the Reach names in the space above the plot.

## H. New HEC-GeoRAS Features

The new version of the HEC-GeoRAS software (version 3.1) includes the following new features:

1. **XS Plot Tool.** Cross sections may be previewed in ArcView using the GeoRAS XS Plot tool. The selected cross section is plotted in an ArcView Chart. The user may interactively select points in the Cross Section Plot using the Point Locator Tool. The point selected is drawn on the plan View. The XS Plot Tool generates a file named “xsplot.dbf” in the same directory as the GeoRAS project is stored.
2. **Ineffective Flow Areas Theme.** GeoRAS 3.1 allows the user to define ineffective flow areas at locations on the cross section that are not actively conveying flow. This is done in the Ineffective Flow Areas Theme. GeoRAS will extract the beginning and ending location of the ineffective flow area along the cross section in the Cross-Sectional Cut Line theme. Elevations at the beginning and ending location are

automatically extracted and the higher of the two elevations is used to estimate the ineffective flow area “trigger” elevation. The user may override the default elevation by specifying an elevation.

3. **Levee Alignment Theme.** GeoRAS 3.1 allows the user to incorporate existing or proposed levee features (or land forms that act similarly to levees) in the geometric data. The Levee Alignment Theme requires the centerline alignment of a levee to be digitized. Elevations for the alignment may then be automatically taken from the Terrain TIN or interactively entered by the user, using the Levee Tool. The location and elevation of the Levee Alignment at each cross-sectional cut line is then extracted. NOTE: The user must have an existing Terrain TIN to utilize the Levee Tool.
4. **Storage Areas Theme.** Users can now define storage area locations. Elevation-Volume data is extracted for each storage area. NOTE: No weir tools are available, but the user can use the XS Plot Tool to generate weir profile information.
5. **Water Surface Profile Results Processing.** There is no longer a limitation on the length of the profile names. The floodplain delineation methods have been improved for computational efficiency.

#### **I. Bug Fixes Since Version 3.01 (March 2001)**

1. Stage and Flow Plotter did not plot the upstream or downstream stage and flow if they were interpolated cross sections.
2. The utility to convert ineffective flow areas to permanent did not show interpolated cross sections, so these could not be set with the tool.
3. There was an error in the table for modifying river stations, in that extra "\*" were sometimes added to the end of river stations.

4. The stage flow plotter locked up when the user turned off all the variables.
5. The stage and flow plotter would display the flow leaving incorrectly if total flow was not plotted.
6. There was an error in the schematic editor when moving a reach into a storage area. This only occurred when multiple storage areas existed.
7. Misspelling on a message when the cancel option is selected on the XS points filter window (loose ->lose).
8. XS Points filter window had incorrect tool tips.
9. The stage and flow plotter labeled the available storage areas "Conn:" rather than "SA:".
10. The filled in water surface on the cross-section plot had an error when the channel was perched with levees on top of the bank stations.
11. On the unsteady flow data editor, the lateral inflow boundary condition for storage areas was not saved and did not work.
12. Storage Area Connections - the program would crash when closing the gate editor.
13. The dialog for "Save Plan As ..." showed the binary log files (e.g. "\\Beaver.p01.blf"), now it does not.
14. The cross-section points filter would inappropriately take out points that defined a horizontal variation in Manning's n values.
15. The cross-section points filter did not set the time of last edits for individual nodes, this could cause bridge tables not to be recomputed by HTAB (unlikely but possible)

16. The Observed DSS data editor did not show interpolated cross sections in the RS combo box, so they could not be selected for connecting to a DSS pathname.
17. Unsteady Gate Opening Boundary data. If the gate opening group name was changed in the geometry, the gate opening data was lost. Now the program tries to match gate names, but if it can't it copies the last gate opening data to the new named gates.
18. The display of Gate openings for the maximum profile was incorrect.
19. The inline structure weir coefficient default was 3.0, and is now 2.6. The lateral weir coefficient default was 3.0, and now its 2.0.
20. On the schematic, the wrong text appeared in the caption when the mouse moved over the editor button for the HTAB parameters.
21. The default for viewing profile names in the profile table has been changed to on.
22. Conspan Culverts - changed the arch rise from 3.07 to 3.00 feet for the 12 and 14 ft spans.
23. Cross-Section plot - it was possible to make the plot window very small and then close it, which caused the program to fail when loading the cross-section plot in the future.
24. Cross-Section plot - when the option for plotting velocity distributions was turned on, and there were not any velocity distributions, the program did not fill in the water surface.
25. Vertical Variation in n values was not converted to SI units, which made the computations always wrong for vertical variation in n.

26. The number of n values for sizing arrays was incorrect for multiple opening bridges if they used internal bridge cross sections with more n values than the bounding cross sections.
27. Hydraulic connections required HTAB parameters for inline weirs and inline weirs with gates. This was not necessary, so this requirement was dropped.
28. The filled-in water surface failed to fill-in rectangular cross sections.
29. The filled water surface had problems on the profile plot on reaches with multiple culverts at different invert elevations.
30. The cross-section points filter had a problem that could end up taking out points such that the final filtered cross section would have differences larger than the input tolerance. The problem occurred because the tolerances were measured against the filtered list not the original section.
31. The report generator did not write out the ineffective flow locations for a cross section.
32. If all of the observed water surfaces in the flow file did not match any of the cross sections in the geometry, then the steady flow computation program would generate an error reading the input file.
33. The storage areas elevation-volume relationship was not converted correctly to SI units.
34. Attempting to plot a DSS record of gate opening data would cause the program to crash.
35. RAS did not save the option to use DSS files for a time series of gate openings.
36. Specifying initial lateral flows generated an error when loading (only worked if the data was entered in the order of upstream to downstream).

37. Conspan culverts with SI units had an error that continually changed the Span.
38. The bounding polygons for GIS floodplain delineation around junctions failed in many cases.
39. A bug in the low-flow/weir-flow computation for bridges was preventing convergence.
40. Buried or filled culverts crashed if a culvert was buried more than halfway.
41. Metric unsteady flow data sets were crashing in the Table program part of the simulation.
42. Split-flow optimization did not work for supercritical flow (mixed flow worked ok).
43. Overbank ice thickness was changing for channel-only ice jam.
44. Files were not being properly closed causing network data set runs to crash.
45. For a bridge with the energy-only option turned on, the area above the road, for the clipped regions (piers, area between openings) was not properly being included in the active flow.
46. Hydraulic connections from river reach to a storage area could only be entered one way. If the user made the connection in by drawing it from the storage area to the river reach, it did not work properly
47. If the return flow from more than one lateral weir was connected to the same cross section, SNET failed.
48. If there was at least one lateral weir that had split flow optimization turned on, and there are also lateral weirs that do not have optimization turned on, the lateral weirs that do not have split flow turned on wouldn't remove water but they were

incorrectly returning it if the downstream side of the lateral weir was connected to a cross section.

49. For a very high degree of submergence (over 95%), the weir submergence criteria transitions from being based on upstream energy vs downstream water surface to upstream energy vs downstream energy (the transition from using the downstream water surface to using downstream energy). This was not being done for lateral weirs.
50. Unsteady flow max change in hydrograph (time slicing) did not work (screwed up the time window for the computations).
51. The Alpha coefficient was not being taken into account during calculations of flow over a weir.
52. Water surface could go below critical depth (and go unstable) just upstream of inline weir.
53. The initial gate opening setting for inline and lateral weirs may not be correct during the [steady flow] backwater computations for UNET (the settings are correct during the “warm up” period).
54. Weir flow calculations did not include the area above permanent ineffective flow areas.
55. Encroachments at internal boundaries. Projecting the encroachment stations is now based on channel stationing instead of absolute stationing.